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A LECTURE

ON

TURNIP FLY,

WITH

METHODS OF PREVENTION AND REMEDY,

DELIVERED AT THE

Royal Agricultural College, Cirencester.

BY

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TURNIP FLY.

AND

METHODS OF PREVENTION AND REMEDY.

The following Lecture on the Turnip Fly, or Flea Beetle, and the methods of treatment and cultivation which have been found serviceable in keeping it in check, was delivered before the Students of the Royal Agricultural College, Cirencester, on Thursday, June 15th, by Miss Eleanor Ormerod.

Amongst the various kinds of Insects which are more or less present every year on our crops, there are a few which especially call for attention from the fact of their being seldom absent, and very often present in such numbers as to cause severe loss.

One of the most injurious amongst these is the Turnip Flea-beetle, commonly known as Turnip Fly; and its habits, and the methods of cultivation by which it may be kept in check, are well worth consideration, as showing how knowledge of the habits of each insect, and the requirement of the crop on which it feeds, may be brought to bear together so practically in the matter of prevention of attack as to be very serviceable.

The history of the Turnip Fly is also a good example

of the method of insect attack not being a matter of mysterious uncertainty.

From the small size of insects and their very different appearance at different stages of their lives, and also from many of their operations being carried on out of sight of all but those who follow the clue given by the state of the injured crop, the fact that their lives are as much governed by laws as those of animals which from their larger size are more easily observable, is not so much thought of as it ought to be.

If it was once settled in the mind that their propagation and their changes from one stage to another, the food they require, and the other methods of carrying on life were subject to rules, and when they altered that they varied with variations in surrounding circumstances, it would give a hopefulness to study, a certainty of benefit repaying investigation, that would be of much service. So long as there is vague uncertainty in the mind of an observer, how can he work with any comfort or confidence? But let him once be convinced by reasonable proof that the insect he is studying has a fixed method of life; that it will die of starvation if it has no food; be cleared out by taking away its shelter; that heat and sunshine, or cold and wet, have *certain* effects upon it; and he will, so to say, go at his work with a will, and he will prosper in it.

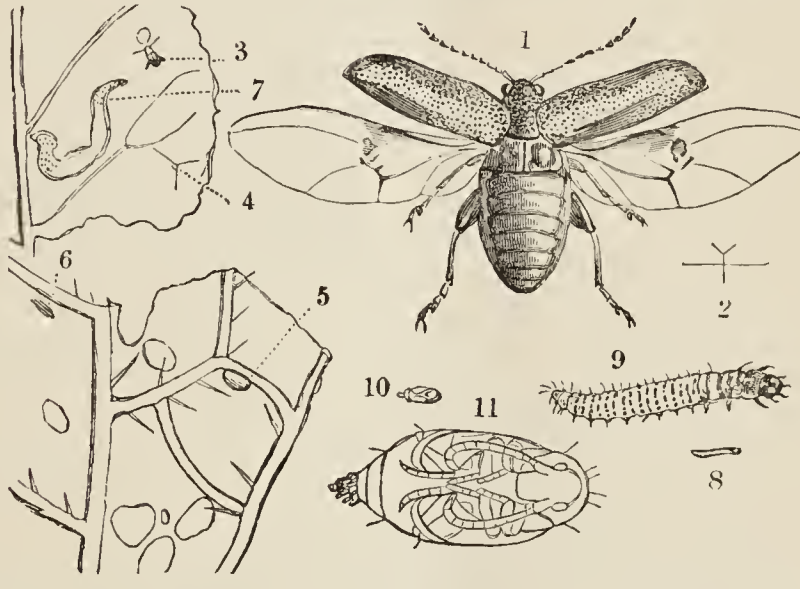
The Life History of the Turnip Fly is well known, but for convenience of reference at present I give the main points as shortly as possible.

The Fly, or more properly the Flea-beetles, live through the winter,—in a torpid state or otherwise, according to the amount of cold,—and under such shelter as is afforded only too often by rough ground, stones, or apparently almost any kind of moderately dry field rubbish.

With the return of sunshine they come out to trouble us, and feed, until the Turnips and Cabbage are ready for them, on such wild plants of the Cabbage kind as they can find—as the common Shepherd's Purse, the

tall weed with large somewhat heart-shaped leaves and white flowers known as Jack-by-the-Hedge, the purple-flowered Ladies' Smock or Cuckoo flower, and others, and more especially Charlock, all which may be known to belong to the order Cruciferæ, or the Cabbage kind, by having flowers with four leaves arranged in the form of a Cross.

Egg laying begins about April. When the attack is on the Turnips the eggs are laid on the under side of the rough leaf; the Maggots soon hatch, and piercing into the leaf feed between the two sides. These Maggots or *larvæ* are full grown in about six days, when they come out of the leaf and bury themselves an inch or two below the surface of the ground near the Turnip.



1—3, *Phyllotreta nemorum;* 4 and 5, eggs; 6—9, maggot; 10 and 11, pupa; all nat. size and magnified.

Here they turn to chrysalids *(pupæ)* from which the Flea-beetles (or "Fly") come out in about a fortnight, and there may be as many as five or six broods during the season. The first brood appears to be at its height in May and June, and it is stated by John Curtis "that it is admitted on all sides that the beetle is weakest in July" ('Farm Insects,' p. 28), which is a very important observation relatively to dates of sowing.

Two of the commonest kinds of Turnip Fly are the

Phyllotreta nemorum and *P. undulata*: these are blackish, with an ochrey or yellowish stripe along each wing-case, and may be distinguished from each other by the *P. nemorum* having yellow shanks, and also being rather larger and more coarsely punctured than the *P. undulata*. Another kind is of a greenish black or brassy tint, and also is distinguished by having a tooth on each pair of hinder shanks. This is known as the Hop or Tooth-

Tooth-legged Flea-beetle, nat. size and magnified; hind leg of ditto, magnified.

legged Flea-beetle, scientifically as the *Chætocnema concinna* (Stephens). Formerly they were scientifically known as different species of *Haltica*.

Two great points to be attended to with regard to Fly are to clear it out beforehand, or to support the crop under the attack if it occurs.

To clear it out we should allow these Flea-beetles no winter shelter in rubbish alive or dead, and we should starve them out in the spring by destroying their wild food-plants, which are mostly very conspicuous, and which keep them in comfortable circumstances until the delicate new food of our crops attracts them to it. But as even with the best care the pest may come from neighbouring shelter over which we have no power, or be borne on the wing in hot sunshiny weather, the next thing is to induce such a hearty growth of the crop as may run it quickly through its first stages to the rough leaf, in which the Fly has much less power over it; and it will be seen

that great benefit may be securely reckoned on by measures falling within the scope of regular cultivation, such as treatment of the ground calculated to preserve the surface moisture in it at sowing time—a fine tilth; the addition of artificial manure to stimulate early growth; good seed and a liberal supply of it; in short, all measures that will tend to cause rapid germination, and to run the plant on well and quickly.

If we take the points to be attended to in regular order, one of the first is—Where does the general appearance of the Turnip Fly which begins the attack in spring *come out from?*

This may be from almost any kind of shelter. On the surface of fields, clods of earth, lumps of rough manure, stones, or even the hollow stalks of standing stubble may serve to protect it. At the sides of fields, heaps of stones and rubbish that are often gathered together and increased in size each year serve it admirably for winter shelter; also it has been seen making progress from a field border of neglected grass by the side of the kind of loose stone wall or bank known in Scotland as a "dyke."

In such situations it is said by John Curtis, who in his day did so much for Agricultural Entomology, "The Fly or Flea-beetles may be seen on the first indications of spring, if the weather prove fine, sitting on walls in considerable numbers, or sunning themselves on dry banks and on clods of earth protected from the wind."

They also harbour amongst dead leaves, which accounts for Fly ravage sometimes beginning at the side of a field only divided by a hedge from woodland, and as they are likewise to be found in decayed stumps, or under loosened bark, an eye should be kept on accumulations of wood rubbish, as well as on other possible shelters.

These are the starting-points from which the parent beetles come out; but as young Turnips are not to be found so early in the year, and the creatures need food, the first brunt of the attack is believed to fall on the weeds of the Cabbage kind that I have just named, and

these should be cleared away wherever it is possible, for three reasons :—1st. To starve the Fly. 2nd. Because the Fly, either by scenting its prey or by some means not yet known, has been shown by the observations of many years to have such powers of finding where there is suitable food and migrating to it, that in the absence of food-plants we may confidently hope it will not come to us, or if present that it will leave us for better supplied localities. The third point is, I think, a very important one, and not brought forward as much as it ought to be. We have seen where the spring attack of the Fly comes out from, but where does the *first brood*, or progeny of these wintered Flea-beetles come from ?

We are told that the Fly begins to lay in April, and that it lays its eggs on the under-side of the rough leaf of the Turnip ; and so it does *in due season*, but Turnips in the rough leaf are not sufficiently plentiful early in the year as to afford leafage for the maggot stage of the coming legions of what has been truly described as "this pest of a Fly"! Prof. Buckman helps us here, as he tells us that the earliest broods are bred on the wild Cruciferæ ; therefore if we clear out all weeds (or waste cultivated plants) of the Cabbage tribe to which the Fly resorts, we cannot fail to do good, both by lessening the amount of Fly then present, and also lessening the amount of the coming brood.

Charlock is especially attractive to Fly. Where this weed abounds the beetles will come to it and feed until Turnips or Cabbage are ready to be attacked, and where the golden carpet of Charlock blossom is seen, there is a spot where Fly ravage is especially likely to be set up, and presently be found extending to the neighbouring fields.

Sometimes this (almost the most pernicious of our weeds) is introduced on the land by the use of cheap Turnip seed, which has been adulterated with that of Charlock, and care in this matter is very desirable. Where farming is on such a large scale that there are plenty of implements the "Koldmoos Weed Eradicator"

has been found useful. This may be described as a horizontal drum revolving at high speed between two carrying wheels, the drum being furnished with rows of combs protruded and withdrawn by machinery, by which the weeds entangled amongst the teeth are pulled up or the flowering heads torn off. Commonly, however, weeding under careful superintendence, so that the work may be thoroughly done, seems the main cure.

Where a stubble is foul with Charlock and other weeds it is a very good plan, as a means of prevention, to run the chain harrows over it, or brush it, and so shed the ripe seeds. These will sprout at once, and the young weeds from them will be destroyed by after cultivation; whereas, if they are left to ripen and shed gradually, these seeds are ploughed in too deeply to germinate at the time, and in the next ploughing they will be thrown near the surface, and will then sprout, and give us a growth of weeds along with the growth of the crop.

The presence of shelter in the winter, and of plants suitable for food to the wintered Flea-beetles and their Maggots in the spring, seem to be the conditions to which we owe attack in ordinary seasons; and when, as in 1879 and part of 1880, we have such long continuance of wet weather as makes it impossible to clean or cultivate the land properly, attack may be looked for as likely to occur in excessive amount.

The long rains were followed by an unusually large appearance of Charlock in various places from the North of Scotland to the South of England, and when the dry hot weather of May, 1881, occurred, which was precisely suited to propagation and spread of the Fly, it burst forth like a plague upon us.

Weather influences bear strongly on the amount of injury caused by Fly attack.

It is most hurtful in hot dry weather accompanied by bright sunshine, because the Fly is then in its fullest vigour, propagates most freely, and also flies well, and consequently spreads far, whilst the young Turnips in such circumstances fail quickly under attack, but when

once Fly attack is established, every circumstance that is bad for the Turnip helps to keep it under the power of the enemy. Frosts that check the growth of the young plant, or cold rain, or cold drought, will all keep it back, and thus, although the Fly will not be multiplying and spreading so rapidly as in hot and bright weather, yet what there is of it on the crop will need food, and the plants suffering from ungenial weather will not be able to grow past attack.

This was shown last year in the report from Dumfries, in which county, and the neighbouring one of Kirkcudbright, scarcely one field of Turnips escaped attack, and many had to be sown a third and even a fourth time. It is said, "We had during three weeks in May an unusually high temperature with very clear sunny days. This gave the beetle a start, and the cold weather of June and July never checked it. If the Turnip had been growing in June and July as they do in an ordinary season, they would have grown out of harm's way; as it was, the beetles overpowered them, eating them off the face of the earth." (R. S. in Inj. Insect Report, 1881.)

At Marchmont, Berwickshire, drought, accompanied by late frost, kept the Turnips under the power of the Fly. From the 21st of May to the 10th of June, no rain fell, and high day temperatures during a part of the time were followed by a drop of the Minimum Thermometer to below freezing-point on five mornings after the 3rd of June, the temperature on the 10th being as low as 23°—that is, nine degrees of frost. "Young Turnips were weak where they were not killed, and easily fell a prey to the vast numbers of Fly." (P. L. in Inj. Insect Report, 1881.)

A slow weak germination and growth through the stage whilst the plant is in its seed-leaves, is the great thing to be guarded against to save the young crop from the Fly. The trouble may be caused, as we have seen, by heat, or cold, or drought, but it may also arise from the land being ill-prepared or under-manured, from the surface being too dry at sowing time, from bad seed,

or in fact *anything unfavourable to plant growth*, and if the plant loses heart it loses all; it most surely will fail under attack. But make it healthy, and in the full sense of the word "hearty," and there is good hope that enough of the crop to afford a paying return will keep its head above the amount of attack of ordinary seasons.

The great principle of cultivation brought forward by our agriculturists is so to prepare the soil beforehand as to ensure a *fine tilth and good seed-bed*, with such small amount of disturbance of the soil at the time of sowing as may preserve the surface moisture in it, and thus, with the addition of some artificial manure, afford conditions favourable for rapid germination and good growth.

In many parts of the Midland and South of England, and especially on strong land, autumn cultivation is considered the best means of warding off Fly attack in the following season. Where land is well ploughed in the autumn, and laid as fallow during the winter (what is sometimes known as stale fallow), the frosted surface mellows down, and is in a good friable state, so as not to require further ploughing in spring. The application of the scarifiers should be enough, and thus the young sprouting weeds will be cleared and the soil stirred sufficiently, whilst by the use of this implement (in whichever of its various forms of cultivator, scuffler, &c., it may be most suitable), instead of the plough we avoid throwing the ground open to the drying winds and baking suns that often occur during the spring. Also we secure the wintered mould on the surface, which forms an excellent seed-bed, and is believed, by various good agriculturists, to be much less attractive to the Fly than freshly turned earth; also, we preserve the stores of moisture (which have accumulated during the winter) undisturbed and ready for use below the surface. This is a very important consideration, for, as pointed out by various writers, if these stores are dried it takes much heavier and more constant rain than we can reckon on in spring or early summer, to lay up a similar supply for the young crop.

There is also the great advantage in autumn cultivation, that where stubble land, whether heavy or light, is foul with weeds, we thus clear out these harbourages of future Fly attack.

Passing on now to the large proportion of cases in which autumn cultivation appears impossible from considerations of climate or other reasons, the same principles at least are applicable, and I quote some excellent advice on this head from the 'Prize Essay' by Mr. Vallentine, of Leighton-Buzzard, published in the 'Journal of the Royal Agricultural Society,' in 1856. He says, "When the season does not permit of autumn cleaning the successful chance of growing a Turnip crop on light land rests upon early working in spring." He considers one ploughing in spring amply sufficient for Turnips in light land, and that this should be given in April at the latest; in another place he says, "Dry Turnip soils should be moved in March or the beginning of April at the latest," and cleaning should be done as early as weather and working of the soil will permit. After the April ploughing the use of the scarifier is advised for the reasons before mentioned, that it pulverises the soil and brings up weeds, but exposes little or no fresh soil on the surface; and attention is forcibly drawn to the state of a foul field cleaned late in the season, where, by ploughing, dragging and harrowing, the soil is so perpetually turned over to the effects of sun and air, that the moisture is as completely dried out of it as out of grass which is perpetually turned over to convert it into hay.

The importance of *keeping the moisture in the ground at sowing time*, was brought forward repeatedly last year amongst the methods of preventing Fly attack. The advice is given "to work the ground down early in the spring to keep it damp"; also that it was found to be good treatment for the land "to be cultivated and manured early, and, after being ploughed twice, made very fine and let remain rolled down for about nine days before planting." It is also advised, "on heavy clay

work ground before, and thus break it up early (say March); work it up for roots nine days prior to planting, and thus cheat the Fly," which the observer remarks parenthetically " will go away with tears in their eyes "!

A fine tilth is also of great importance in driving on rapid growth of the young plant in its first stage, and partly because this state of ground gives the best conditions for healthy germination. Germination requires warmth, moisture, and some air, and where there is a fine tilth the seed is in far better circumstances in all these respects than where the ground is rough or " cloddy " as it is termed, and therefore part of the seed is buried under great lumps of earth, and part exposed on the surface to drought or anything that may happen.

The fine soil preserves the under-lying moisture evenly, and evaporates it gently, and besides, makes a good bed for the young rootlets.

In the reports of last year the importance of good tilth as a measure of prevention of Fly ravage was most strongly dwelt upon. It is said " Good tilth and condition are the chief auxiliaries to push the plant out of the way of the Fly "; again, " the finer the tilth the less are its ravages "; also, " the finer the ground is got before cultivation the quicker the plants come away, and the better and faster they grow out of the way of the Fly." One more of the many notes sent on this subject draws attention to a yet further advantage we gain by removing shelter from the Fly. It is said, " a fine tilth is most desirable; the parts of a field first hopelessly injured are those where the surface is the roughest, the small clods causing the moisture to dry out more quickly and *affording shelter* to the Fly from breezes which it does not like."

If the previous measures of cultivation have been good, this tilth will have been forming itself of the mellowing soil, but no good comes of trying too late in the season, when the soil is baking under a hot sun, to pound as it were the clods into manageable form. We certainly may get a powdered surface, but that dry bed,

unless rain comes beyond what we can reckon on, will be anything but a serviceable Turnip tilth.

It should be borne in mind that, although the measures before named suit our common circumstances, whatever will bring about our object of affording the seed a good genial seed-bed will answer just as well. For instance, in the neighbourhood of Ardkinglas, by Inverary, one field alone was noted to have escaped Fly ravage, and this was a stubble which had not been ploughed until just before sowing. But the field lay in a damp locality along the banks of the River Fyne, and a fine and *moderately damp* mould was turned up, the seed was *immediately* sown, and a good braird and crop followed.

In this case natural circumstances gave what we often can only gain by very careful cultivation, and it shows that, whilst on one hand no prudent farmer would fail to prepare regularly for the state of things commonly to be expected, yet at the same time we should be on the watch to alter or modify our operations as circumstances may direct; and if it happens that the condition of the ground or passing weather gives us a chance of a good seed time, we should on no account let even half a day slip whilst we are trying to gain the same object by rule.

Rainfall at sowing time is often beneficial in the highest degree; in fact, the saving of the plant and the following observations taken in 1881, at Boro-bridge, Yorkshire, are of much value in shewing the absence (or the very small amount) of Fly attack that took place on plants germinated in thoroughly moistened ground, compared to the bad attacks on sowings made when the land was dry or only moistened by showers.

It was noted that sowings made on the 19th, 21st, 25th and 26th of May, were all attacked by Fly, and in two of the four instances eaten off. The weather at the time was warm and dry, and though there were showers on the night of the 24th, the amount of rainfall observed at the neighbouring station at Aldborough, was only 0·18—that is, rather less than the fifth of an inch. The

total rainfall from the 1st of April until the 13th of May, inclusive, had only been one inch, and the subsequent fall up to the evening of the 26th of May was half an inch, which would be rapidly absorbed or evaporated in the warm and dry state of the weather and ground. On the night of the 26th there was such heavy thunder-rain, amounting to 0·54 (or rather more than half an inch fall), that it prevented getting on the land to go on with the drilling (begun on that day and the previous one) until the 28th, and this later drilled part of the field which was sown after the heavy rain came well, and gave an excellent crop, although, as we have seen, the part sown before the heavy downpour was entirely cleared by the Fly.

Seed put in on another plot of the farm on the 28th was also not touched by Fly, excepting a dozen or so of ridges next to one of the previously infested localities; and save one plot redrilled on badly infested land which was partly eaten, the rest of the plots sown at various dates, from the 4th to the 27th of June, (when rainfall was commencing or was well established, or the ground well sodden by the thunder-rains of the 28th), were not touched by "Fly," although in one instance the ground was reported to be in anything but good condition for Turnips, as it worked very rough.

Similar effects of heavy rain in clearing off the Flea-beetles are also noted from Berwickshire, where it was observed that the insects had it all their own way until the heavy rainfall of the 16th and 17th of June. The rains up to ten tons and fifteen tons per acre had no perceptible effect, and it was not until there was a fall equal to fifty-eight tons on the 16th, and forty-eight on the 17th, that the last of the Fly disappeared.

The amounts here given correspond with what we have just been noticing at Boro-bridge. A fall of one inch of rain represents a fall of a weight of 101 tons per acre, and consequently the falls recorded of 48, 54 and 58 tons per acre would be respectively rather less and rather more than a half-inch fall. It saves some trouble in calculation, as rainfall is usually recorded by the inch and 100th of an

inch, to note that—as an inch fall represents 101 tons per acre—for general rough estimate 100th of an inch nearly corresponds with one ton of rainfall.

A downpour of rain that is heavy as well as large in amount, does good in dry weather, partly by setting up supplies of moisture in the ground that help germination, and also render the manure or food in the ground available to the young plant, and partly by fairly beating the Fly off the leaves, and checking its activity for a while. When Flea-beetles are wet they cannot leap, from their leaping legs being clogged with moisture. I have watched infested Turnips at the beginning of a gentle rain, and as the moisture gathered together the Flea-beetles gradually lost their power of skipping away; and in the case of a heavy fall, many of those that were beaten into the soaked ground would take some time before they could put themselves to rights again to continue their attack.

The point of securing the benefit of rainfall was much brought forward last year, and the advice was given from various places to sow before or after rain—"not in the dry." Of course where land is *clogged* with wet it would be wrong to work it for seed whilst in that state.

How far artificial application of moisture with the seed (or after sowing) can be brought to bear, is a point that we need to know more about. When the season is moderately damp the use of the water-drill has been found to do much good; on the other hand, in dry seasons it has been found to do harm, by just starting the plant into a growth that there was no further supply of moisture in the dry ground to carry on.

The use of the water-cart has been found to bring up a lagging crop, and by experiment it has been shown that, measure for measure, a plot of young Turnips watered on two or three evenings, when germinating, will weigh one quarter more at the end of a fortnight than that which was unwatered, but at present, except occasionally or in garden cultivation, there does not seem any way of applying irrigation over head at a paying rate to the field crop.

As to date of sowing, opinions differ, and probably this must differ with climate and circumstances, but the larger proportion of last year's observers are in favour of late sowing; a few are in favour of sowing early, but the medium time seems the most *un*desirable, and this view corresponds fairly with the observations of John Curtis, of the Fly being weakest in numbers in July; also about this time there are usually some intervals of rain or thunderstorms alternating with warm sunshine, which are favourable to the plant, and (as noted) bad for the "Fly."

Thick seeding is strongly advised as a Fly preventive, and shown to answer by instances given of the plant doing well where the supply was liberal, and failing under attack where the amount was small.

The quantity usually thought desirable appears to be 3 lbs. per acre; but at one locality in Haddington 5 lbs. are regularly used, and at another near Sunderland 6 lbs. is the amount, of course taking care that thinning is looked to in good time.

Amongst the many minute points to which attention was turned in the bad attack of 1881, a case was noticed at Eaglescairnie, Haddington, where the stopper had been accidently left out of the seed barrel, and some yards were sown extraordinarily thick, and enough plants escaped "Fly" attack on this part for a crop. Also near Bromyard part of a field was accidentally drilled with the Mangold barrel and was thus about four times too thick; that part, although covered with Flea-beetles, recovered; the rest of the field sown with the Swede barrel had to be resown.

An experiment tried at Fans, Berwickshire, bears well on the above points. A field was sown with Swedes between the 12th and 14th of May, the greater part at the rate of 5 lbs. per acre; but by way of trial the rest of the field (that is 8 drills) was sown at the rate of 9 lbs. per acre throughout. The part of the field sown with 9 lbs. was thinned on the 20th of June, whilst of that sown with 5 lbs. a portion was not ready until the 4th of

July, and the rest had to be resown, and on the 2nd of November the crop on the drills sown at the rate of 9 lbs. was estimated as worth £4 or £5 per acre more than the part sown with 5 lbs., although all were sown at the same time, and the same seed and the same treatment used throughout.

This was an experiment in unusual and extreme circumstances, and valuable accordingly; commonly the point needing attention is to provide enough plants to stand Fly attack (which may generally be expected more or less strongly), if it comes, but also to keep good watch lest, if it should *not* come, the plants should run each other into a valueless and spindly growth, which may be the result of even one or two days' delay in thinning. The benefit of thick sowing is partly from the obvious fact that a certain amount of Fly cannot eat up more than a certain amount of Turnip plants, and although the Fly will eat broadcast, not sparing any, yet thus the amount of injury will be distributed over a larger number of plants, and its effects will be less deadly. It is also said by some growers that a thick-sown crop is the soonest ready for the hoe; this I conjecture to be because in dry weather the young sprouting plants that are thickly placed have much more of the moisture they need, around and on them, than when they are sparingly scattered over the ground. The night dews fall on the leafage instead of being absorbed and to a great extent lost in the dry earth, and there is also a damper surface beneath their leafage than in the field around.

The question of whether *steeps or dressings* for seed really act as preventives for Fly attack appears as yet quite *undecided*.

Petroleum has been used in the proportion of one gill to moisten 10 lbs. of seed. Spirit of turpentine has been used in the porportion of 8 oz. to about 28 lbs. of seed, the seed being frequently stirred, and drilled three days after with a mixture of chalk and sand. Paraffin has also been used; and these various applications have

been found to answer well (or at least to have been followed by absence of Fly) in instances recorded, but instances are also given of some of these and other applications being of little if any benefit.

The great difference in these results suggests that the effect may depend in part on the state of the weather and of the ground at the time of application, and that the preventive effect arises from the scent or the presence of the steep or dressing making the ground, or the young plant coming up through it, obnoxious to the Fly, or prevent it being attracted by the peculiar smell of the food-plant, on which subject I wish to offer a few words presently. In hot and dry weather scent would diffuse itself gradually, and dustings or dressings of lime and soot remain serviceable, whilst in the case of heavy rain the dressings and the scent would be removed together. This effect of rain was shown last year in an instance where a mixture of equal parts of carbolic powder and sulphur with a small proportion of soot were used to drill with the seed; the mixture kept the Fly away until rain washed it off, and then the plant was attacked and destroyed.

Another possible method of action of some of the steeps (which is open to proof or disproof by analysis) is such absorption of the diluted steep taking place by means of the rootlets as makes the plant unsuitable for food for the Fly. This is a matter for minute chemical investigation, but looking at the fact of various matter, including a form of phenol, having been shown to be thus absorbed, it appears worth further consideration.

The action of manure as a preventive falls into the Agricultural and chemical department, as the amount and nature must vary with circumstances, but it may just be observed that in case of farmyard manure being applied shortly before sowing it should be covered over at once so as to preserve the moisture, and also no dry lumps should be left on the surface, as they shelter the Flea-beetle. Also, though some amount—and a liberal amount—of artificial manure is highly desirable as an

addition to push on first growth, it is possible to give too much, and cause the after growth to be over-stimulated rather than sound and healthy.

When the plant has fairly sprouted and attack takes place, the methods of remedy or mitigation lie in means of catching the Fly and destroying it wholesale; of applications (mechanical and otherwise) by which the Fly may be disturbed from its destructive work and destroyed, and repellent dressings.

The plan of running tarred boards over the plants has been found to work well, by reason of the Flea-beetle *taking its customary leaps* to avoid the enemy, and consequently becoming attached to the tar. In the plans of driving sheep, dusting, dressing, &c., one great point is to secure that the Flea-beetle can *not take its customary leaps*, and thus escape us; therefore we see the reason of making these applications (as advised on all hands) late in the summer evening, or early in the morning, or after a light rain, when the leaping legs of the Flea-beetles are clogged, and thus they are at our mercy. They may be brushed or trampled into the earth or mixed up with the dressing, and if we do not kill all we stop the progress of their work for a time, and even if this time is only a couple of days it is a great relief to an infested crop in the seed-leaves.

Applications of dilute soft-soap, which are serviceable in garden cultivation, act by clogging the Fly and making the food distasteful, and possibly in other ways besides direct action as plant stimulants.

I have now detained you almost too long, but yet I wish to add a few words.

We all know the importance of this crop and our great losses in it last year. On only half the acreage in Swedes and Turnips of the 33 English and Scotch Counties, from which I had returns in 1881, this was estimated at more than half a million of directly calculable loss on seed and outlay alone for one resowing. A waste, utterly *un*remunerative outlay, as it was to gain a crop, that, but for the "Fly" we should have had without it, and a sum also not nearly covering the real

damage through late crops, loss of food for stock, and consequent derangement of farm routine, and loss of farm material.

We have seen that, throughout the course of Fly attack, there are points by which this may be much aggravated or diminished; we see this in many parts of the history almost with mathematical precision; the Flea-beetles that torment us *must* have a locality somewhere during the winter; and if we clear out these beetles with their shelters, by just so much we are sure of absence of attack,—it may come from elsewhere, but we do something.

With regard to what comes from elsewhere, I wish to direct your attention to some points which have lately been brought forward for the first time as a principle of Insect prevention, by one of the great authorities on these subjects, Prof. J. A. Lintner, State Entomologist, New York.

He shows the probability—or rather the extent to which it can be proved—that insects have powers equivalent to those of perception of scent in the higher animals, and that what are called repellent dressings, such as gas-lime, tar, kerosine, and the like, act in part by so overcoming the plant scent that it does not attract the feeder, and he gives notes of microscopic investigations, from which the organs of scent in many instances are considered to be placed in pits and sensitive bristles on the *antennæ* or horns; some beetles appear to be without them, as the Weevils,—some, as the Chafers, to have them in vast numbers.

Practically we all know that insects are sometimes attracted to each other, and to their food or place for egg-laying, by circumstances in which action of sight cannot be the guiding power; and in the special case of Flea-beetles we know they will fly up the wind to their prey, and also migrate in bodies to a more suitable crop.

If this matter can be practically or scientifically worked out and proved correct, we have an engine of prevention and remedy placed in our hands of which the

importance cannot be over-estimated. As far as my own observations go I think it is very likely that we *shall* find it correct. For some years I have inclined to think attack with various crops especially followed on rough weeding and thinning, in which the smell from the bruised plants and those left perishing on the land spread in the air; but I had not, until receipt of Prof. Lintner's paper, the key to the reason.

If we could have experiments as to effect of various strongly scented dressings including in these both such as are known to be unattractive,—as various forms of tar, or paraffin, kerosine, petroleum, &c., also of dressings of gas lime or mixtures of sulphur,—and on the other hand, of effects of special animal manures, some of which are either attractive or at least have had their application followed by appearance of "Fly," we should gain very beneficial information, and also it would be worth while to note whether any increased attack could be definitely shown to follow the operation of thinning.

Analysis of the constituents of plants to which different dressings have been applied would also (in connection with absence or presence of attack) be very serviceable, as well as notes of the effect of different applications on rapidity of growth; and, Gentlemen, nowhere better than in your hands could these points be worked out scientifically, and the results given in information for practical service which would be highly beneficial to us all.

I am indebted to the courteous liberality of Messrs. Blackie & Son, Glasgow, for the use of the illustrations, which are from the pencil of John Curtis.

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